

## **Analysis of foods for heterocyclic aromatic amine carcinogens.**

Mark G. Knize and Cynthia P. Salmon

Biology and Biotechnology Research Program, Lawrence Livermore National Laboratory, Livermore, CA 94550

Carcinogenic heterocyclic amines are natural products present at part-per-billion levels in muscle meats when they are cooked over 150°C. Determining the importance of the heterocyclic amines in human health requires accurate exposure (consumption) data to be combined with the results of toxicological and epidemiological studies.

The analysis of heterocyclic amines in foods is challenging because foods are a very complex sample matrix and multiple compounds need to be analyzed at very low levels. Several hundred food samples were analyzed for heterocyclic amines using solid-phase extraction and HPLC, and mutagenic activity was determined with the Ames/*Salmonella* test.

Cooked meats generally contain PhIP, MeIQx, and DiMeIQx with low amounts for meat products from fast-food restaurants (<1 ppb total of PhIP, MeIQx, and DiMeIQx). Commercially cooked meats from conventional restaurants have undetectable levels to 15 ppb of heterocyclic amines. Laboratory-cooked samples show varying results. Chicken breast meat samples showed surprisingly high levels of PhIP(>50 ppb) when cooked over open flames compared to beef cooked similarly. Amino-alpha-carboline can be present in amounts over 100 ppb in beef but not chicken grilled over open flames. Ground meats have lower amounts of heterocyclic amines than intact muscle pieces of the same size cooked identically.

Mutagenic activity testing (strain TA98 with S9) showed that only a few non-meat samples had activity typical of aromatic amines, notably toasted breads and grain-based coffee substitutes. The relationship between heterocyclic amine content and mutagenic activity shows that MeIQx, DiMeIQx and PhIP account for most of the measured mutagenic activity of fried meats. In contrast, meats cooked over an open flame have much higher mutagenic activity than can be accounted for by known heterocyclic amines, suggesting the presence of unidentified mutagens.

(This work was performed under the auspices of the U.S. DOE by LLNL under contract W-7405-Eng-48 and supported by NCI agreement YO1CP2-0523-01 and National Cancer Inst. grant CA55861).